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(19)

(54) PROCESS AND APPARATUS FOR THE CONTINUOUS REGENERATION OF RUBBER AND PLASTICS

(71) I, STEFAN FICKER, a citizen of Germany, of 16 Gorlitzer Strasse, 6074 Urberach, West Germany, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a process and apparatus for the continuous reclamation of rubber and plastics from waste material and damaged goods, especially pneumatic tyres or technical rubber articles.

For different reasons, the reclamation of such waste material is of considerable importance and by reason of the fact that there are very large amounts of these goods — the yearly world supply of used motor car tyres will shortly reach the billion mark — their disposal is a big technical and economical problem.

The object of the reclamation process is not merely to dispose of the waste material, but to convert the rubber and plastics into a form in which they can be usefully employed. The use of these reclaimed materials as components for mixing with fresh raw material is of major econonic interest. Some of the desirable characteristics, especially the strength and the elongation at rupture, are partly lost in the course of all previously proposed procedures for the reclamation of the material, but not to such an extent that the reclaimed material could only act as an inactive filling compound. It can replace the fresh raw material to an important extent and even improve it in some respects. For example, the tensile strength of new rubber is from 250 to 400 kp./cm², and the tensile strength of the reclaimed material, depending upon the procedure used for the regeneration and the material itself is from 40 to 150 kp./cm². The reclaimed material still has sufficient strength to take over part of the function of the fresh raw material. Moreover, the coefficients of some desirable characteristics of rubber compounded with reclaimed material are even higher than for rubber not compounded with reclaimed material.

The various prior thermal or chemical processes for reclamation generally give a useful reclaimed material, but these processes are discontinuous although they are relatively profitable. However, they usually result in a high degree of contamination of the atmosphere and long periods are needed for the reclamation.

The previously proposed processes for reclamation involving extrusion can be conducted continuously but need considerable power to operate them, in view of the power needed to disintegrate the material. Moreover, these processes involve high abrasion of the screw of the extruder and a lot of spare parts are needed. Moreover, only a material without fibres can be made and the apparatus needed for separating the components resulting from the process is very expensive and needs a lot of time for servicing.

It has been proposed to reclaim rubber or plastics in a screw device working as a screw conveyor substantially at ambient pressure, the device comprising one indirectly heated screw. This proposal, however, has not been adopted in practice because the reclaimed material does not have the desired quality. Incrustation and the different residence times of the particles prevent the manufacture of a homogeneous reclaimed material.

In a hitherto unpublished proposal, the material to be reclaimed is heated to a temperature of at least 60° C. and is then fed to the screw device where it is moistened with a regeneration fluid and a softener. The reclamation is effected in an indirectly heated multiple screw device which operates substantially without pressure and as a screw conveyor with nearly meshing screws. The material is heated to 140 to 200° C.

[Price 25p]

Following this proposal a reclaimed material of good quality can be economically manufactured with a reclamation time of 3 to 30 minutes.

This invention seeks to avoid the preheating of the material before feeding it into the multiple screw device — as well as a secondary treatment in a regeneration pot after the multiple screw device, and nevertheless to manufacture a reclaimed material which is more homogeneous and of better quality than was previously obtained.

According to the present invention there is provided a process for the continuous reclamation of rubber or plastics from waste material containing it, wherein the material in a crushed form is moistened with a softener and reclamation fluid and is indirectly heated in a multiple screw device having at least one pair of parallel adjacent screws, the radial peripheries of which overlap but which are not in contact so that there is between the flanks of adjacent screws and between the flanks of the screws and a surrounding casing, the screws being disposed in a self-cleaning arrangement in which the flank of one screw can peel off material from the flank of an adjacent screw, whereby the material is depolymerised substantially at ambient pressure the resulting product being then homogenised in conventional manner.

The material to be reclaimed will first be crushed and cleaned from possible fabric ply or reinforcing fibres or other plies and contaminations, the material preferably being crushed to a granular size in the range 0 to 3 mm. The surface of the material is then moistened with the softener and regeneration fluid, preferably in a continuously working mixer. The resulting preprocessed material should then be piled in a bunker in order to allow the fluid sprinkled on in the mixer to diffuse throughout the material.

The multiple screw device is conveniently heated by the introduction of a heated liquid heat carrier.

The screws and the housing of the multiple screw device may be heated by the introduction of a heated liquid heat carrier which has substantially no vapour pressure at the temperature of application.

The heat carrier can be passed into the screws which may be hollow, and their shafts as well as into the housing. For some vulcanized material, it is preferable only to heat the screws and their shafts in order to avoid incrustations. Because nearly 80% of the exchange of heat occurs through the screws and their shafts, the throughput load will be practically unchanged by this mode of action.

Heating is most economically effected using a fluid heat carrier which has substantially no vapour pressure till nearly 350° C.

Preferably the material fed to the multiple screw device is indirectly heated to a temperature of 180 to 300° C., preferably 240 to 280° C.

Depolymerisation of the material in the multiple screw device is preferably effected for a period of from 5 to 25 minutes.

The temperature of the heat carrier and the speed of rotation of the screws determine the residence time of the material in the multiple screw device and can be continuously variably adjusted to suit requirements.

The hot reclaimed material leaving the screw device will be transported directly for further manipulation into a refiner, strainer or rolling mill which serves as a heat exchanger and apparatus for further treatment of the material.

By this means it is possible continuously to make a reclaimed rough sheet or a strand without any intermediate treatment. This process is possible because the multiple screw device can be readily mounted above the machines for the further manufacturing and because the product is obtained continuously and in adjustable quantities. In the course of further processing in refiners or rolling mills the material can be fed to the mills by means of distributor attachments.

The apparatus for carrying out the present process comprises means for moistening the crushed material with a softener and reclamation fluid, a multiple screw device adapted to be heated and having at least one pair of parallel adjacent screws, the radial peripheries of which overlap but which are not in contact so that there is a short distance between the flanks of adjacent screws, the device including a casing surrounding the screws so that there is also a short distance between the flanks of the screws and the surrounding casing, the screws being disposed in a self-cleaning arrangement in which, when the device is in operation, the flank of one screw can peel off material from the flank of an adjacent screw, and means for homogenizing the resulting product.

Preferably alternate screws are equipped with different numbers of starts and flights.

In order to enable the invention to be more readily understood, reference will now be made to the accompanying drawings, which illustrate diagrammatically, and by way of example an embodiment thereof, and in which:—

Figure 1 is a diagram of apparatus for reclaiming rubber or plastics, and

Figures 2*a* and 2*b* are cross-sections of two different multiple screw devices which may form part of the apparatus shown in Figure 1, Figure 2*a* showing a devic with

four screws in a hood and Figure 2*b* showing a device with two screws in a hood.

Referring now to the drawings, there is shown apparatus in which metered quantities of a regeneration fluid and softener are fed through conduits 2 and 3 into a heated mixer 1. The materials are fed at such a rate that the amount in the mixer is constant and they are mixed by a stirrer 4. Crushed waste rubber from pneumatic tyres is fed through an inlet 7 into a continuously working mixer 6, the rubber still containing the reinforcing fibres of the tyres. The mixture of regeneration fluid and softener is fed through a conduit 5 and sprinkled in metered quantities onto the rubber material in the mixer 6. After leaving the mixer 6, the thus prepared rubber material is stored for some hours in a silo (not shown) and is then fed through a conduit 8 continuously and in metered quantities into a multiple screw device 9 having two or four screws 11 and 12 (Figure 2*b*) or 11, 12, 11*a* and 12*a* (Figure 2*a*) the radial peripheries of adjacent screws overlapping but the screws not being in mesh. A fluid heating medium is fed to the screws 11 and 12 through a conduit 10 and emptied through a conduit 13. Fluid heating medium (heat carrier) is pumped into the casing of the device 9 through a conduit 14 and is removed through a conduit 15. The screws 11 and 12 are driven by a motor 16 through a steplessly variable change-speed gear 17. The rubber material comes out at 18 and falls directly into a refiner 19 which operates at the same time as a heat exchanger by means of water-cooled mills 20 and 21 which cool the material. The rough sheet 22 produced in the refiner is then treated in conventional manner in other refiners.

The multiple screw device comprises one or two pairs of screws, each pair comprising a single-thread screw combined with a double-thread screw which is driven by the single-thread screw at half its speed of revolution. Because the screws 11 and 12 revolve with a different number of revolutions and in the same direction of rotation, the screw flanks always have different peripheral speeds and are therefore self-cleaning. The distance between the working screw flanks is chosen in such a way that the screw flanks nearly intermesh, the distance between the flanks of adjacent screws being under 4 mm.

Upper and lower parts of the housing of the multiple screw device are shaped in the region of the screws, so that there is a short distance between the housing parts and the radial outlines of the screws. By this means the screws are also self-cleaning relative to the housing.

While modern thermal and chemical procedures are profitable and economic in expenditure of energy, they may result in the generation of low temperature carbonizing gas and thus cause atmospheric pollution. In some situations, the time for reclamation and drying is over 12 hours. These procedures can only be operated batchwise. However, the present process is continuous and leads to a high quality product.

Although reclamation may be effected continuously by using an extruder, the construction expenses and energy consumption are high and considerable abrasion of the screws occurs while the physical values and technical values of the reclaimed material are poorer than those of the product of the present process.

The present multiple screw device with its self-cleaning screws, permits any gases or vapours evolved during the treatment in the device to be sucked out, at the mouth of the screw because of the small width of the device and the immediate cooling of the material.

WHAT I CLAIM IS:—

1. A process for the continuous reclamation of rubber or plastics from waste material containing it, wherein the material in a crushed form is moistened with a softener and reclamation fluid and is indirectly heated in a multiple screw device having at least one pair of parallel adjacent screws, the radial peripheries of which overlap but which are not in contact so that there is a short distance between the flanks of adjacent screws and between the flanks of the screws and a surrounding casing, the screws being disposed in a self-cleaning arrangement in which the flank of one screw can peel off material from the flank of an adjacent screw, whereby the material is depolymerised substantially at ambient pressure, the resulting product being then homogenised in conventional manner.

2. A process as claimed in Claim 1, wherein the multiple screw device is heated by the introduction into the screws of a heated fluid heat carrier, which has substantially no vapour pressure at the temperature of application.

3. A process as claimed in Claim 2, wherein the heated fluid heat carrier is introduced into the screws and the housing.

4. A process as claimed in any one of Claims 1 to 3, wherein the material is heated to a temperature of 180 to 300° C.

5. A process as claimed in any one of Claims 1 to 4, wherein the material is heated to a temperature of 240 to 280° C.

6. A process as claimed in any one of Claims 1 to 5, wherein the depolymerisation of the material in the multiple screw device is effected for 5 to 25 minutes.

7. A process as claimed in any one of

Claims 1 to 5, wherein the depolymerised material from the multiple screw device is fed directly into a refiner, strainer or rolling mill working as a heat exchanger and is there homogenised as a rough sheet or strand.

8. A process for the continuous reclamation of rubber or plastics substantially as hereinbefore described with reference to the accompanying drawings.

9. Apparatus for carrying out the process claimed in any one of Claims 1 to 8, comprising means for moistening the crushed material with a softener and reclamation fluid, a multiple screw device adapted to be heated and having at least one pair of parallel adjacent screws, the radial peripheries of which overlap but which are not in contact so that there is a short distance between the flanks of adjacent screws, the device including a casing surrounding the screws so that there is also a short distance between the flanks of the screws and the surrounding casing, the screws being disposed in a self-cleaning arrangement in which, when the device is in operation, the flank of one screw can peel off material from the flank of an adjacent screw, and means for homogenising the resulting product.

10. Apparatus as claimed in Claim 9, wherein the or each pair of screws comprises a single-thread screw combined with a double-thread screw arranged to be driven by the single thread screw at half its speed of revolution.

11. Apparatus as claimed in Claim 9 or 10, wherein said distance is under 4 mm.

12. Apparatus for the continuous reclamation of rubber or plastics substantially as hereinbefore described with reference to the accompanying drawings.

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1373155 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

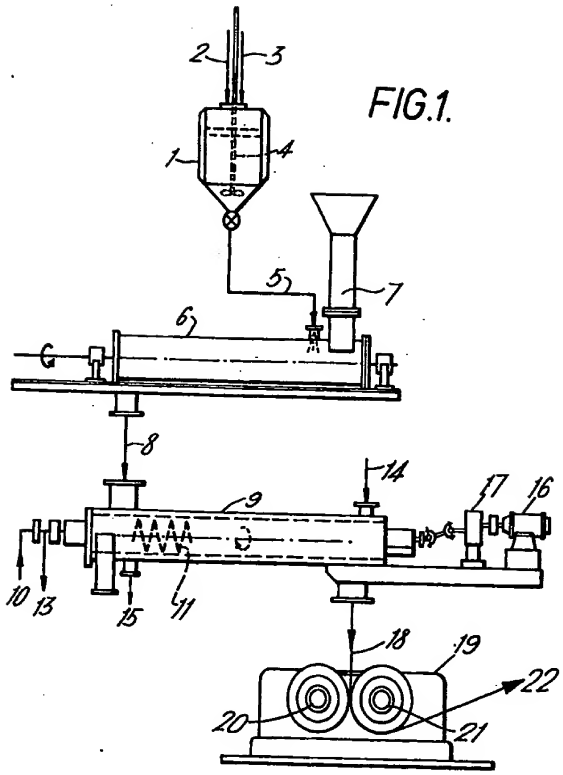

FIG.1.

FIG.2a.

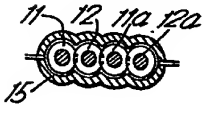

FIG.2b.